Process Integration and Opportunities of Industrial Heat Pumps

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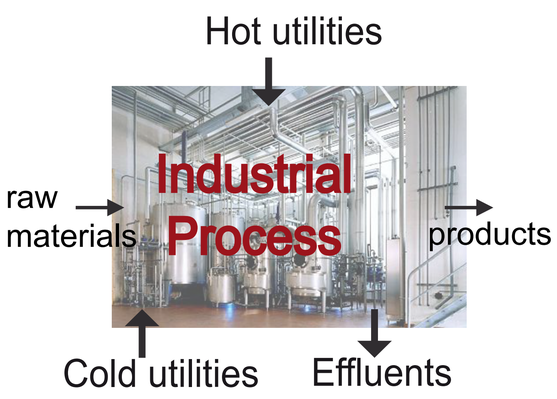
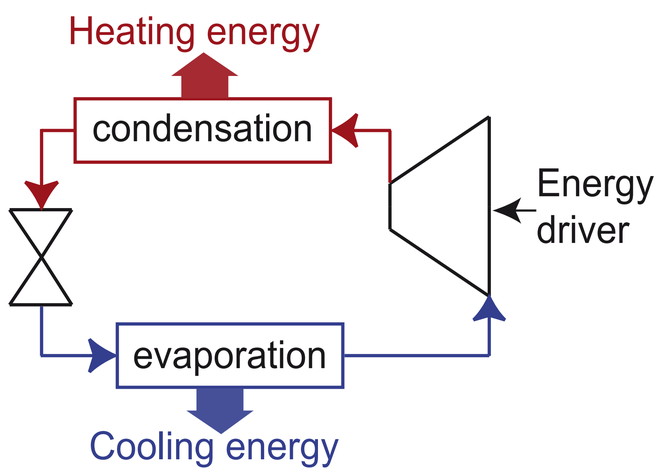
Motivation & Objectives

- Optimization of industrial processes
- Development of a methodology to integrate heat pumps

Decreasing energy demand	Decreasing operating costs	Increasing process efficiency	Decreasing CO2 emissions

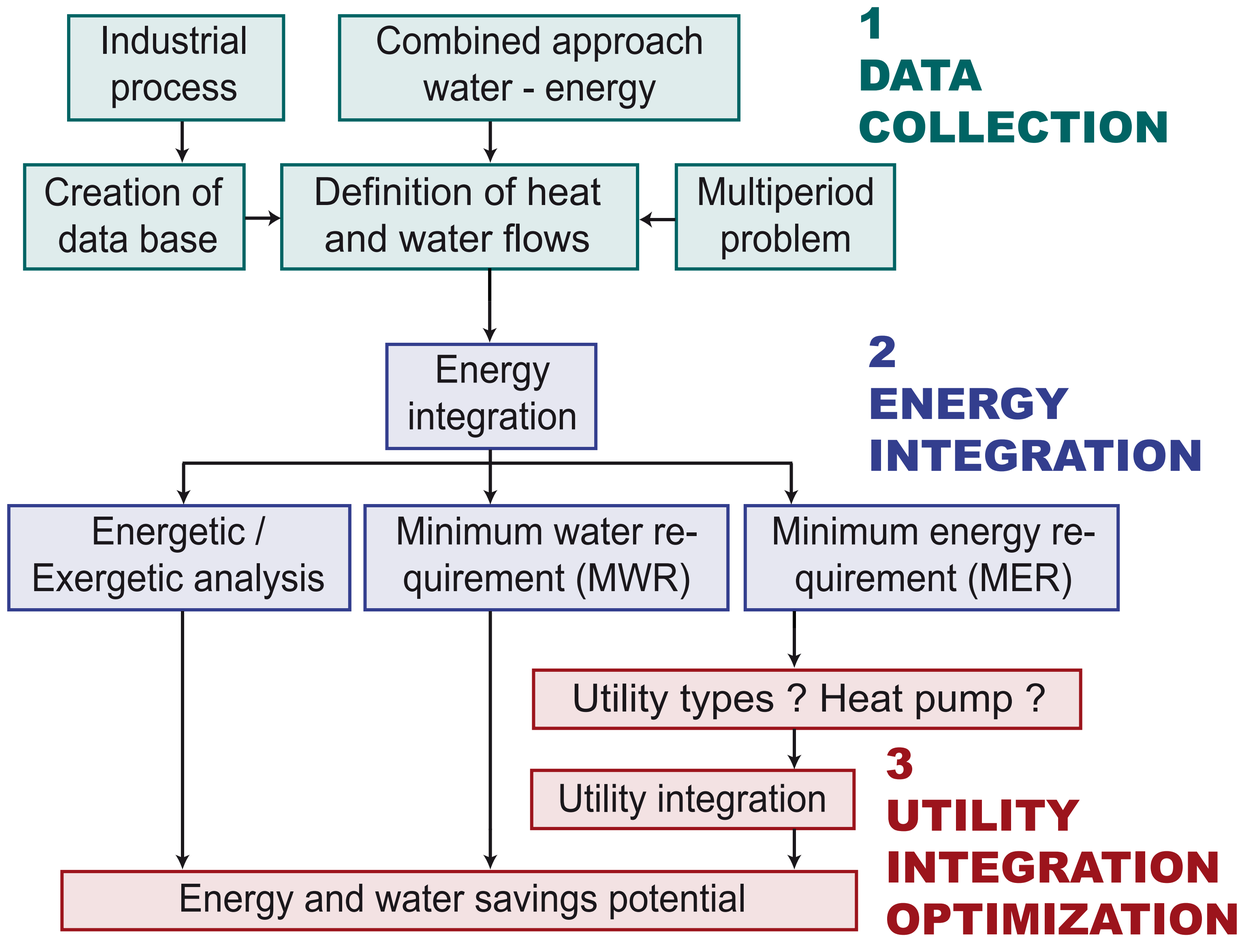




Heat pump potential ??

Heat pump integration
Technology selection

Approach / Methodology



Results - dairy process

- In comparison to a reference case with optimal heat recovery

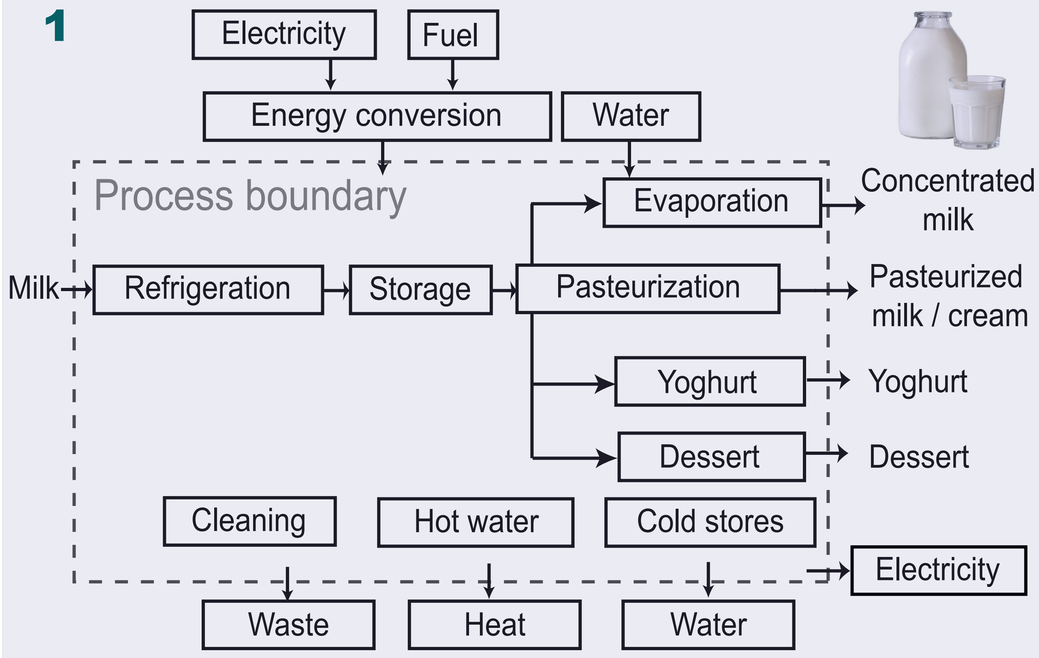
	Unit	REF	HP	HP&COG	MVR&COG
Operating costs	[MCHF/y]	0.6778	0.4865	0.4190	0.4073
Saving potential	[%]	0	-28	-38	-40
Fuel consumption	[kW]	1708	854	1708	1760
Saving potential	[%]	0	-50	0	+3
Electricity	[kW]	316.77	403.07	-265.37	-331.81
Saving potential	[%]	0	27	-184	-205
CO_2 emissions (EDF mix)	[tons]	979	515	946	971
Saving potential	[%]	0	-47	-5	-1
CO_2 emissions (UCTE mix)	[tons]	1324	951	946	971
Saving potential	[%]	0	-28	-29	-27
Cooling water consumption	[kg/s]	42.11	14.39	14.39	14.39
Saving potential	[%]	0	-66	-66	-66
Exergy efficiency	[%]	31.1	43.7	45.9	47.5

Reference
Becker, H., Maréchal, F., and Vuillermoz, A. 2009. Process integration and opportunity for heat pumps in industrial processes.
22nd International Conference on Efficiency, Cost, Optimization Simulation and Environmental Impact of Energy Systems - ECOS2009

Example of application

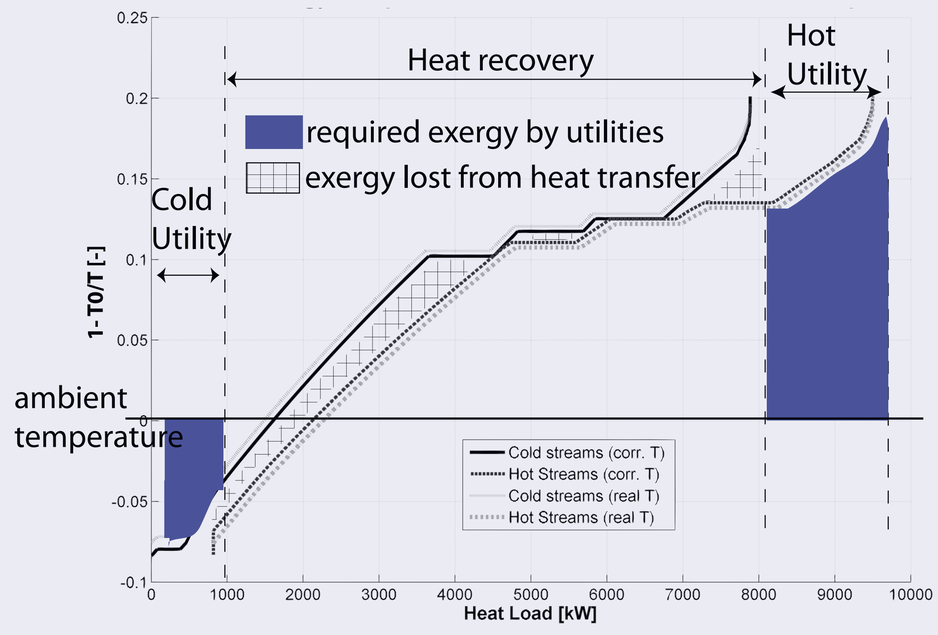
Process system

1



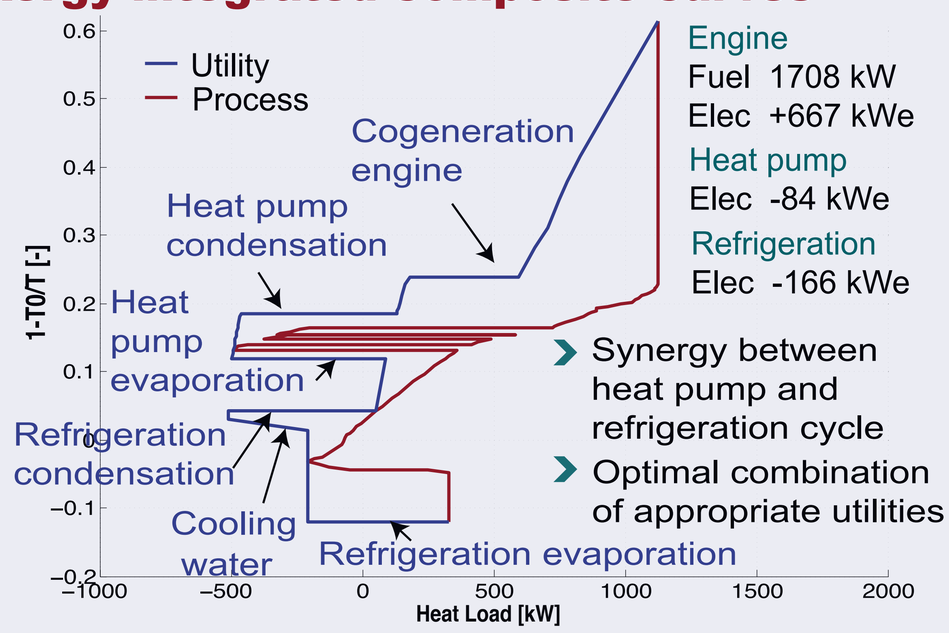
Exergy hot and cold composite curves

2



Exergy integrated composite curves

3



- Synergy between heat pump and refrigeration cycle
- Optimal combination of appropriate utilities

Perspective

- Energy integration of industrial sites with heat exchange restrictions→ subsystems and intermediate heat networks
- Multi-period problems and energy storage

Acknowledgements

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